Appendix
Supplemental Technical Analysis

As a preliminary matter, as fully discussed in the legal analysis attached as Attachment "1" to the cover letter transmitting Duke Energy's responses to IDEM's Request for Additional Information ("Responses"), which legal analysis is here incorporated by this reference, Duke Energy disagrees with the position of IDEM staff regarding the meaning of the term "infiltration" and the phrase "releases of CCR, leachate, or contaminated run-off to the ground or surface waters" as they are used in 40 C.F.R. § 257.102(d)(1)(i). However, assuming for the sake of argument that these interpretations are correct, without withdrawing Duke Energy's objections to the positions espoused by IDEM staff, following is a description of (i) how the closure plan meets the closure-in-place requirements, including, without limitation, the requirement to control, minimize, or eliminate post-closure infiltration and releases to the maximum extent feasible; (ii) the actions Duke Energy will take to address the lateral migration of liquids underneath the final cover system; and (iii) corrective measures to prevent further releases, remediate releases, and restore affected areas. This Supplemental Technical Analysis also discusses the environmental impacts and risks associated with closure by removal of CCR (*i.e.*, excavation).

I. How The Closure-In-Place Performance Standard Will Be Met And How The Lateral Migration Of Liquids Under The Final Cover System Will Be Addressed

Pursuant to Section 257.102(d) of the CCR rule, CCR surface impoundments capped in place must meet an extremely stringent performance standard to minimize or eliminate the infiltration of precipitation into the capped CCR; releases of ash into the ambient environment; and releases of CCR, leachate, and contaminated run-off to surface waters or the ground. In order to meet this strict standard, Duke Energy will go beyond the requirement to install a soil-only cover and will also install a durable synthetic cover system designed to minimize infiltration and erosion and will take measures to provide for major slope stability to prevent damage to the cover system. In addition, following closure of the impoundment, Duke Energy will conduct a minimum of 30 years post-closure care for the unit, which includes, among other things, maintaining a groundwater monitoring system, monitoring the groundwater, groundwater assessment, and undertaking appropriate corrective action measures if groundwater contamination exceeds applicable standards.

As detailed in the closure plan submitted to IDEM, Duke Energy will grade CCR materials to achieve design cover system subgrade, install associated stormwater management controls, and stabilize the site with appropriate vegetation and final erosion and sediment control measures. The proposed geomembrane and soil for the final cover system detailed in the closure plan will result in a lower infiltration rate than the 1 x 10^{-5} centimeters per second standard. Importantly, although the CCR rule does not require use of a geomembrane to meet the closure-in-place performance standard, in order to provide the most effective barrier between the CCR and the environment, Duke Energy will use a geomembrane when closing CCR surface impoundments that are capped in place.

The materials proposed for the vegetative support layer will provide equivalent or greater performance than the six-inch-thick erosion layer required under the CCR rule. Finally, in accordance with Section 257.102(d)(2)(i)'s requirement that free liquids be eliminated by removing or solidifying liquid wastes before installing the final cover, the closure plan explains that bulk water/free liquids will be removed from the unit throughout multiple phases of construction, and interstitial/pore water will be removed during construction as needed to provide a workable surface for the final cover system installation. These combined measures, including diversion of wastewater and stormwater, bulk dewatering, and selective interstitial dewatering, will stabilize the remaining wastes sufficient to support the final cover system in accordance with the requirements of 40 C.F.R. § 257.102(d)(2).

EPA makes the following clear in guidance—guidance that is *current* and posted on the agency's Web site:

> The dewatering of a surface impoundment is a necessary first step in ensuring that the eventual closure of the unit will meet the statutory standard under RCRA of "no reasonable probability of adverse effects on human health or the environment." Over the long-term the closure of the CCR unit will substantially reduce the significant health and environmental risks associated with these units. . . .

https://www.epa.gov/coalash/relationship-between-resource-conservation-and-recovery-acts-coal-combustion-residuals-rule. Irrespective of the location of ash with respect to the water table, Duke Energy expects closure in place will reduce groundwater contamination impacts relative to current conditions. EPA determined, and Duke Energy's analyses agree, that dewatering surface impoundments substantially reduces the risk of groundwater contamination because such impoundments are "no longer . . . subjected to hydraulic head so the risk of releases, including the risk that the unit will leach into the groundwater," is minimized. 80 Fed. Reg. at 21342 (Apr. 17, 2015). EPA more fully discussed this issue in its HUMAN AND ECOLOGICAL RISK ASSESSMENT OF COAL

COMBUSTION RESIDUALS (Dec. 2014) in support of the final CCR rule, wherein the agency explained that it

> considered the potential impact of postclosure releases through a sensitivity analysis. This sensitivity analysis modeled closed surface impoundments equivalent to closed landfills, with the full constituent mass still available to leach without replacement. *The results of this comparison show that releases from surface impoundments drop dramatically after closure, even with waste in place. This is because the large hydraulic head present during operation forces leachate into the underlying soils at a faster rate, resulting in higher releases to ground water than can occur postclosure.* <u>Based on these findings, EPA concluded that the assumption of clean closure has a negligible effect on modeled risks.</u>

Id. at 5-28, 29 (emphasis added and internal references deleted).

Thus, by dewatering an impoundment and preventing infiltration of precipitation and run-off through installation of a final cover system, the reduced hydraulic head will reduce the movement of coal ash constituents into the groundwater thereby reducing risks to human health and the environment. Indeed, groundwater modeling quantifying the potential impacts of CCR constituents on groundwater supports EPA's position in the CCR rule that closure in place and closure by removal can be equally protective, provided that they are implemented properly. 80 Fed. Reg. at 21412.

II. Evaluation Of The Groundwater Protectiveness Of The Two Surface Impoundment Closure Options

In November 2016, Gradco, LLC ("Gradient") produced a report titled "Evaluation of the Groundwater Protectiveness of Potential Surface Impoundment Closure Options" [hereinafter, "Gradient Report"] a copy of which is attached to these Responses as **Exhibit "1,"** wherein it detailed numerical modeling of closure in place and closure by removal using MODFLOW and MT3DMS for a range of typical surface impoundment conditions to evaluate and contrast the level of groundwater protectiveness provided by each closure option. Under both options, owners and operators must dewater their impoundments, which results in removal of the hydraulic head. Accordingly, it is not surprising that the Gradient Report concluded that both closure in place and closure by removal "provide significant beneficial impacts to groundwater quality and that neither of the closure options is always more beneficial, with respect to downgradient groundwater quality, than the other." Gradient Report, at ES-1, 16. In fact, depending on the site-specific conditions, including constituents of interest, size of the impoundment, time required to complete the closure option, and hydrogeological conditions, Gradient concluded that closure in place can provide "a greater degree of contaminant reduction in downgradient groundwater monitoring wells." *Id.* Importantly, "[i]ntersecting and non-intersecting groundwater conditions largely did not affect which closure option was more favorable," and any differences between closure in place and closure by removal due to such conditions were "generally minimal." *Id.* at ES-1, 16-17. In fact, "[t]he level of groundwater protection provided by the two closure options was similar under all the scenarios modeled," Gradient concluded.[1] *Id.* at ES-1, 17.

Gradient notes that "[s]urface impoundment closure evaluations must be made on a case-by-case basis, considering site-specific conditions and hydrogeological characteristics." *Id.* at ES1, 16. This is consistent with *current* EPA guidance, which explains that the CCR rule "recognizes different factors on a site specific basis are important for determining the best method of environmental protection at individual disposal unit sites and thus provides technical criteria to enable flexibility where appropriate to achieve the requirements of the rule." https://www.epa.gov/coalash/relationship-between-resource-conservation-and-recovery-acts-coal-combustion-residuals-rule.

III. Potential Corrective Action Measures To Address Remaining Contamination

As an initial matter, it is important to point out that 40 C.F.R. § 257.97(c)(1)(4) requires owners and operators of CCR units to consider the "potential for exposure of humans and environmental receptors to remaining wastes" in selecting a corrective action remedy. Duke Energy performed investigations for potential private or public drinking water wells (receptors) downgradient from CCR impoundments that are part of closure plans submitted to IDEM. No potential receptors are present. The lack of private wells downgradient of Duke Energy's CCR surface impoundments means that regardless of groundwater impact, there will be no human exposure. When Duke Energy evaluates potential for exposure, as required by the CCR rule as part of corrective measures, it will show that there is no potential for human exposure.

[1] Based on a 30-year horizon, Gradient found that the relative percent difference between time-weighted average constituent concentrations under closure in place and closure by removal was less than 10 percent for every scenario it simulated. Gradient Report, at ES-1, 17.

EPA explains in the preamble to the CCR rule that the corrective action remedy "must protect human health and the environment, attain the groundwater protection standards, control the sources of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of appendix IV constituents into the environment." 80 Fed. Reg. 21407. This statement offers support for the proposition that to the extent any CCR is in contact groundwater, any contamination is to be addressed, as appropriate, under the CCR rule's corrective action provisions at 40 C.F.R. §§ 257.96-98, not its closure provisions at 40 C.F.R. § 257.102. In accordance with the CCR rule's corrective action requirements, Duke Energy is currently undertaking an assessment of corrective measures under 40 C.F.R. § 257.96. Groundwater corrective action, when implemented as part of a combined remedy with closure in place, "could result in a greater and more rapid reduction of contaminant concentrations in downgradient groundwater than [closure by removal] for all scenarios." Gradient Report, at ES-1, 18.

As needed, corrective action will be implemented at each unit to address groundwater detected with Appendix IV constituents at statistically significant levels above the groundwater protection standard. Various corrective measures will be considered, as required by Section 257.96 (Assessment of corrective measures) of the CCR rule. Although there are numerous technologies to remediate organic constituents, fewer options exist to address inorganic constituents, such as those found at the Indiana sites. With such a wide range of inorganic constituents with variable geochemical reactivity, the potential remedial alternatives are limited.

As detailed in **Exhibit "2"** (Potential Remedies Evaluation Criteria) and **Exhibit "3"** (Selection of Remedy Standards) attached hereto, the CCR rule sets out a deliberative step-wise decision-making process under its corrective action provisions designed to identify the proper, technically feasible remedies for addressing groundwater contamination, including the development of corrective action assessments and public involvement. Until this deliberative process has been completed, including the public meeting at which the owner or operator must discuss the results of the corrective measures assessment, no final remedy may be selected. EPA explains in the preamble to the final CCR rule that "selecting a remedy is closely related to the assessment process and cannot be accomplished unless a sufficiently thorough evaluation of alternatives has been completed." 80 Fed. Reg. at 21407. The agency further explains that "there are a variety of activities that may be necessary in order to select the appropriate remedy (*e.g.*, discussions with affected citizens, state and local governments; conducting on-site studies or pilot projects); and, once selected, to implement the remedy (*e.g.*, securing on-site utilities if needed, obtaining any necessary permits, etc.)." *Id.*

Following is a list of groundwater remedial technologies that exist for *potential* implementation at the Indiana sites based on *site-specific* conditions. It is important to stress that the remedies listed below are only *potential* remedies; no final remedy may be selected until the deliberative process discussed above has concluded.

- In-Situ Technologies

    - Groundwater Migration Barriers – Low permeability barriers can be installed below the ground surface to prevent groundwater flow from reaching locations that pose a threat to receptors. Barriers can be installed with continuous trenching techniques using bentonite or other slurries as the low permeable barrier material to prevent migration of groundwater. Barriers of cement/concrete and sheet piling can also be used. Barriers are most effective at preventing flow to relatively small areas or to protect specific receptors. Protecting larger areas is possible if the constituent of concern is not highly soluble and cannot follow a diverted groundwater flow pattern. The barrier will change the groundwater flow conditions, and at some point the increased head (pressure) will cause a change in flow patterns. This will generally be around the ends or beneath the barrier. For instances where constituents of interest ("COI") occur as a separate phase, such as oils and solvents, which are not highly soluble in water, barriers can be effective in preventing the migration of the COI. To ensure that groundwater will not flow beneath the barrier, it must be sealed at an underlying impermeable layer such as competent bedrock with very limited fractures. Groundwater migration barriers are often used in conjunction with groundwater extraction systems (see below). The barriers are used to restrict flow to allow extraction systems upgradient of the barrier to collect groundwater.

    - Stabilization/Immobilization

        - In-Situ Chemical Immobilization – The placement of chemical reactants within areas of high constituent concentrations to immobilize dissolved phase concentrations through precipitation or sorption can be an effective approach to reducing downgradient migration of dissolved constituents. Reagents such as ferrous sulfate, zero-valent iron, organo-phosphorous mixtures, and sodium dithionate have been evaluated as potentially effective for coal ash-related constituents. Two issues that must be considered with this technology are permanence of the reaction product insolubility and the ability to inject the reactants sufficiently to ensure adequate contact with the COI.

    - Permeable Reactive Barrier – General design involves excavation of a narrow trench perpendicular to groundwater flow similar to a groundwater interceptor trench and then backfilling the trench with a reactive material that either removes or transforms COI as the groundwater passes through the permeable reactive barriers ("PRB"). Unlike simple barriers, the PRB can be designed to include impermeable sections to funnel the flow through a more narrow and permeable reactive zone.

  - Groundwater Extraction – Groundwater extraction removes constituent mass from the groundwater and can provide hydraulic control to reduce or prevent groundwater constituent migration. Groundwater can be removed from the aquifer through the use of conventional vertical extraction wells, angled wells, horizontal wells, or collection trenches and their associated pumping systems. The efficacy of each method is dependent upon site conditions.

- Groundwater Treatment

  - pH Adjustment – Adjustment of the pH of extracted groundwater, which may be required prior to discharge, is a simple and extremely well proven technology. For acidic water with a pH below 6, which is the most common for coal ash-related groundwater, metered addition of sodium hydroxide may allow reliable adjustment to within the constraints of any discharge requirements.

  - Precipitation Technologies – Precipitation of metals and other inorganic constituents has been used extensively in treating impacted groundwater. The process involves the conversion of soluble (dissolved) constituents to insoluble particles that will precipitate such as hydroxides, carbonates, or sulfides. For some constituents, an additional oxidation step is needed to convert the constituent to a less soluble and more easily precipitated form. The insoluble particles are then removed by physical methods, such as clarification and/or filtration. The process usually uses pH adjustment, addition of a precipitant, and flocculation. The solubility of the specific constituents and the effluent quality requirements will determine the process specifics.

  - Adsorption Technologies – Groundwater containing dissolved constituents can be passed through columns filled with adsorption media that attract and accumulate the target ions onto the adsorbent surface and reduce their concentration in the bulk fluid phase. When adsorption sites become filled, the column must be regenerated or disposed of and replaced with new media. Common adsorbent media include activated alumina, copper-zinc granules, granular ferric hydroxide, ferric oxide-coated sand, greensand, zeolite, and other proprietary materials. This technology may also generate a significant regeneration stream.

- Exchange Technologies – Ion exchange is a well proven technology for removing metals as well as other constituents of concern from groundwater. With some constituents, ion exchange can achieve very low effluent concentrations. Its effectiveness is sensitive to a variety of untreated water characteristics. It is used less frequently than precipitation and is often used as a polishing step in water treatment processes. Ion exchange is a physical process in which ions held electrostatically on the surface of a solid are exchanged for target ions of similar charge in a solution. The medium used for ion exchange is typically a resin made from synthetic organic materials, inorganic materials, or natural polymeric materials that contain ionic functional groups to which exchangeable ions are attached. After accumulation and saturation of the resin with the target ions, the resin must be regenerated, which involves treatment of the resin with a concentrated solution, often containing sodium or hydrogen ions (acid). The regeneration stream may contain a much higher concentration of the target metal.

- Membrane Technologies – There are a number of permeable membrane technologies that can be utilized to treat impacted groundwater for metals and other constituents. The most common is reverse osmosis, although microfiltration, ultrafiltration, and nanofiltration are also used. All four technologies use pressure to force impacted water through a permeable membrane that rejects the target constituents. The differences in the technologies are based on the size of the molecules rejected and the corresponding pressures needed to allow the permeate to pass through. These technologies can capture a number of target compounds simultaneously and can achieve low effluent concentrations, but they are also very sensitive to fouling and often require a pretreatment step. Like ion exchange, they also result in a relatively high volume reject effluent, which may require additional treatment prior to disposal.

- Monitored Natural Attenuation – Where appropriate, monitored natural attenuation ("MNA") will be considered. MNA is a strategy and set of procedures used to demonstrate that physiochemical and/or biological processes in an aquifer will reduce concentrations of COI to levels below regulatory standards or criteria. The mechanisms that regulate their release from solids and movement through aquifers are, for the most part, the same processes that control movement of CCR leachate in an aquifer. These processes attenuate the concentrations of inorganics in groundwater by physical and chemical means (*e.g.*, dispersion, dilution, sorption, and/or (co)precipitation). Dilution from recharge to shallow groundwater, mineral precipitation, and COI adsorption will occur over time, thus further reducing COI concentrations through attenuation. MNA is often used in combination with other groundwater remediation technologies, such as groundwater extraction or with source control, such as engineered cover installation or a hybrid option. Regular monitoring of select groundwater monitoring wells for specific constituents is conducted to ensure COI concentrations in groundwater are attenuating over time.

IV. Environmental Impacts And Risks Associated With Closure By Removal of CCR

Although closure by removal is recognized as a closure method under the CCR rule, EPA recognizes that closure by removal may not be appropriate under all circumstances. In fact, in the preamble to the CCR rule, the agency recognized that "most facilities will likely not clean close their CCR units given the expense and difficulty of such an operation." 80 Fed. Reg. at 21412. Closure by removal may not be an appropriate approach upon consideration of impacts this method of closure would have on, among other things, the broader environment, worker safety, the local community, and resource usage. These impacts must be balanced against any risks—to the extent such risks exist—that might be presented by the closed-in-place CCR surface impoundment. If the weight of engineering and scientific evidence demonstrates that the capped impoundment meets the applicable performance standard and that human health and the environment will be protected, the owner or operator of the CCR unit is free to select that method of closure.

Analyses comparing the overall impacts of closure in place and closure by removal reveal that, as EPA declared on page 21412 of the CCR's rule's preamble, once closure is complete, both methods are "equally protective" of public health and the environment. However, closure by removal can result in more significant environmental impacts than would be expected to occur by capping the CCR in place. As a result, it will often be the case that closure in place is the preferred closure option from an environmental, human health, and worker and public safety standpoint.[2] As EPA explains in *current* guidance, "[o]verall, dewatering and leaving CCRs in place may offer important environmental safeguards and monitoring. *Closure with waste in place*

[2] The reasons for this are essentially twofold: (i) the length of time associated with closing CCR surface impoundments through closure by removal and (ii) the activities associated with this closure method.

may help avoid sizable transportation related impacts by eliminating the significant truck traffic that would accompany off site movement of CCRs." https://www.epa.gov/coalash/relationship-between-resource-conservation-and-recovery-acts-coal-combustion-residuals-rule (emphasis added).

In June 2016, the Tennessee Valley Authority ("TVA") issued its Final Ash Impoundment Closure Environmental Impact Statement ("EIS") to meet its voluntary commitment to close CCR surface impoundments at a number of its facilities brought about by operational changes in its coal-fired fleet.[3] In the Final EIS, TVA concluded that excavation activities associated with closure-by-removal can take "significantly longer," than under cap in place, because all the CCR must be removed from the CCR surface impoundment before the site may be reclaimed. Depending on the size of the impoundment and the quantity of CCR contained therein, the closure-by-removal alternative may require many more decades than capping the CCR in place. As a result, "the benefit to groundwater quality is expected to be less than the Closure-in-Place Alternative because water infiltration through the CCR would essentially be stopped much earlier when the final cover system is in place." TVA EIS Part I, at 66. Furthermore, under the closure-by-removal alternative, "any ongoing surface water impacts would be reduced more slowly because precipitation events would continue to influence flows from the CCR facility until the end of the closure process." TVA EIS Part I, at 76.

TVA also concluded that less adverse environmental impacts are associated with cap-in-place. "[I]n most situations, Closure-in-Place likely will be more environmentally beneficial than Closure-by-Removal, especially when the amount of borrow and CCR material that must be moved to and from a site is substantial." TVA EIS Part I, at 32-33. TVA's conclusion "confirm[ed] . . . EPA's determination that either Closure-in-Place or Closure-by-Removal would be equally protective if conducted properly." TVA EIS Part I, at 34. TVA considered the impacts of closure in place and closure by removal on many different resources, including air, groundwater, land, noise, public safety, and surface water, and estimated that it would take less than five years to close an impoundment in place and many decades to close an impoundment by removal, depending on size. TVA EIS Part I, at 23. Concluding that "Closure-in-Place with a geomembrane is considered to be one of the best options for improving groundwater

[3] Because TVA is a federal corporation of the United States, it determined that the environmental review requirements of the National Environmental Policy Act had been triggered, because the closure of a CCR surface impoundment constitutes a major federal action significantly affecting the quality of the human environment. TVA's EIS is divided into two parts. Part I is a programmatic analysis generally applicable to any CCR surface impoundment in the TVA system. Integrating the findings and conclusions of the programmatic EIS, Part II analyzes the specific environmental impacts associated with the closure of each of TVA's CCR surface impoundments.

quality beneath or downgradient of an ash impoundment or landfill," TVA found that as the size of the CCR surface impoundment (and, thus, the more CCR to remove) and the distance from the site to the final point of CCR disposition increase, the adverse impacts associated with closure by removal also increase. TVA EIS Part I, at 128. TVA concluded that "[g]reater impacts from emissions, GHG contribution, safety and traffic operations may be expected to result in greater cumulative [and long-term] effects on these resources associated with th[e closure-by-removal] alternative."[4] TVA EIS Part I, at 141.

The increased traffic and idling caused by vehicles used in the excavation and transport operations associated with closure-by-removal will result in increased greenhouse gas emissions and emissions of conventional air pollutants. TVA EIS Part I, at 113 ("Unlike [Closure-in-Place], the Closure-by-Removal Alternative could have a substantially greater volume of truck traffic hauling CCR to a permitted landfill."); TVA EIS Part I, at 49-50 (Closure-by-Removal "results in significantly greater (minimum of three-fold for NOx emissions) and a maximum of nine-fold (for GHG emissions) relative to the adverse impacts of in-place closure scenario. . . ."); TVA EIS Part I, at 45 (explaining it was determined the closure by removal alternative would generate higher fugitive particulate matter ambient concentrations than closure in place because of the increased number of emission sources related to earth-moving activities and equipment movement on on-site and off-site unpaved haul roads).

Moreover, TVA concluded increased traffic congestion and the additional number of large trucks on the roadways would result in more traffic-related deaths and injuries, as well as increase the risk of spills, under closure by removal versus closure in place. TVA EIS Part I, at 30 ("For those impoundments containing greater volumes of CCR, the duration of removal activities would extend for prolonged periods. This would result in greater environmental impacts associated with noise and emissions, degradation of

[4] A February 9, 2019, article in The Dominion Post exposes the issues associated with the kind of truck traffic that could be experienced by a community under a closure-by-removal scenario. The article refers to a "a continuous parade of dump trucks" with "[e]ngines [that] strain loudly against the weight when the trucks are full [and] . . . . [w]ith every pothole a thunderous slam of bed on frame when the trucks are empty." Appearing in front of the county commissioner, a resident made two predictions: (1) the road could not tolerate this kind of traffic, and (2) the residents would not tolerate the trucks. Some four months later she returned to explain that the "road is crumbling." Although the article referred to coal trucks, the impact of ash trucks could be expected to be the same. Available at https://www.dominionpost.com/2019/02/09/fort-martin-road-residents-say-coal-trucks-impacting-quality-of-life/. Reflecting these concerns, coal ash legislation currently moving through the Virginia General Assembly includes a provision that would shield the county from truck traffic associated with closure by removal of the CCR surface impoundments. The sponsor of this language explained that moving ash out of the site would be "unfeasible" and would "severely interfere with normal commuter traffic." Available at https://www.richmond.com/news/plus/speaker-cox-seeks-to-shield-chesterfield-from-recycling-truck-traffic/article_b4006e0a-d6e4-530b-8315-73fa98aa3952.html.

roadway infrastructure (for truck movement, but probably for rail movements too when trucks have to be used to move CCR from the rail unloading facility to the landfill), increased risk of injuries and death, and increased potential for accidental releases."). In addition, because "[d]eep excavations into the CCR impoundment required under the Closure-by-Removal Alternative are particularly dangerous as noted by reports of accidents leading to injury or death in the industry," closure by removal is expected to result in increased prevalence of on-site worker accidents and fatalities as compared to capping CCR surface impoundments in place. TVA EIS Part I, at 135.

TVA's conclusions in the EIS concerning the net environmental impacts of closure by removal are supported by Gradient, which concluded that

> because the model-predicted groundwater constituent concentrations are similar under both closure options, other environmental and safety factors, such as the impacts of the [surface impoundment] closure options on air quality and nearby communities, worker safety, and cost, may be significant when evaluating the overall benefits of the two closure options.

Gradient Report, at ES-2, 17-18. In selecting a corrective action remedy, owners and operators of CCR units are compelled by the CCR rule to consider the "risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant." 40 C.F.R. § 257.97(c)(1)(iv). In light of this requirement, combined with EPA's instruction that site-specific factors are "important for determining the best method of environmental protection at individual disposal unit sites, https://www.epa.gov/coalash/relationship-between-resource-conservation-and-recovery-acts-coal-combustion-residuals-rule, it is axiomatic that the factors (*i.e.*, risks) set out in paragraph (c)(1)(iv) of Section 257.97 must also be considered when making basin closure determinations.

TVA's and Gradient's findings are supported by a technical memorandum produced by Dr. Lisa Bradley at Haley & Aldrich, Inc. ("Haley & Aldrich") titled "Risk of Remediation – Midwest Truck Traffic Evaluation" attached hereto as **Exhibit "4,"** which analyzes the potential additional risks to workers and the public associated with closure by removal of CCR. Using station-specific inputs, such as tons of CCR to be excavated, number of truck trips, truck miles, and project duration, Haley & Aldrich estimated risks of fatality and injury due to off-site truck traffic associated with ash basin excavation projects at Duke Energy's Cayuga, Gallagher, and Wabash River Stations.[5] The Haley & Aldrich analysis estimated—

- 0.23 truck-related fatalities and approximately six truck-related injuries could occur during an assumed Cayuga excavation remedy to an off-site repository;
- 0.09 truck-related fatalities and approximately two truck-related injuries could occur during an assumed Gallagher excavation remedy; and
- 0.35 truck-related fatalities and approximately nine truck-related injuries could occur during an assumed Wabash River excavation remedy.[6]

Although the Haley & Aldrich analysis does not consider rail transportation, impacts caused by rail construction and the potential for accidents resulting from thousands of loaded rail cars traveling across the state (or multiple states) must also be considered in the net environmental impacts analysis.[7] For example, on February 13, 2016, a man was killed by a coal ash train while he was attempting to cross tracks in Pittsylvania County, Virginia. https://www.wsls.com/news/man-dead-after-being-struck-by-train-in-pittsylvania-co. More recently, on July 26, 2018, a driver was injured when his truck was struck by a train carrying coal ash while crossing tracks in Wellford, South Carolina. https://www.goupstate.com/news/20180726/driver-injured-after-train-strikes-truck-in-wellford.

Dr. Bradley's analysis was based on the table attached hereto as **Exhibit "5"** titled "Projected Excavation Details for Duke Energy's Indiana Stations." This table was prepared by Duke Energy to determine the approximate volume of CCR, project duration, and number of truck trips over the project duration that would be associated with closure by removal of the CCR units at Cayuga, Gallagher, Gibson, and Wabash River Stations.[8] Because of uncertainties associated with the length of time it takes to close a basin by removal of CCR, the chart considers "typical" (assumes 500,000 tons per year excavated) and "aggressive" (assumes 1,000,000 tons per year excavated) scenarios. Because the analysis conservatively assumes construction of on-site landfills

[5] Estimated risks of fatality and injury due to truck traffic were not calculated for Gibson Station because all ash is assumed to remain on-site.
[6] Duke Energy is committed to worker health and safety. These estimates, which are based on national statistics, may be considered to help inform the remedy-decision process.
[7] In addition, the secondary impacts of off-site disposal must be considered. Excavation and off-site disposal requires either the disposal of waste to a greenfield site (*i.e.*, a new site never before used for waste disposal) or to a currently permitted landfill. Given the difficulty of developing new permitted landfill capacity, the notion of filling up currently permitted space with coal ash is inconsistent with concepts of sustainability.
[8] All ash is assumed to remain on-site at Gibson Station.

where sufficient landfill space or existing capacity exists, the calculated truck trips and miles traveled represent only that volume of ash that would be trucked for off-site disposal if closure by removal of these units were required. Based on this analysis, excavation of a single site (Wabash River) could be expected to take upwards of 18 years to complete with more than 460,000 truck trips and over 23 million truck miles travelled over this time period.[9] And if IDEM were to require Duke Energy to close all of the CCR units at these stations by removal of CCR, this monumental task would require an estimated 890,000 off-site truck trips totaling over 44 million miles while providing little to no concomitant environmental benefit.

V. Conclusion

As consistently reflected in Duke Energy's plans and actions, Duke Energy is committed to closing all of its CCR units in ways to safeguard worker safety, protect the environment, and minimize impacts to surrounding communities. Relying on science and engineering to drive our decision making, Duke Energy is closing its CCR surface impoundments in a manner that will allow it to achieve closure without unnecessary delay, cost, and impact. Case-by-case decisions on which closure option to choose are driven by sound technical data gathered and analyzed by licensed engineers and scientists. Although both closure methods can be equally protective and provide similar benefits to groundwater, as detailed in these Responses, for myriad reasons, closing the subject CCR surface impoundments in place on plant property will better protect the environment and public health and safety. Accordingly, Duke Energy respectfully requests that IDEM promptly approve its closure plans.

[9] Assumes 50 round-trip miles from the Wabash River Station to the off-site landfill.